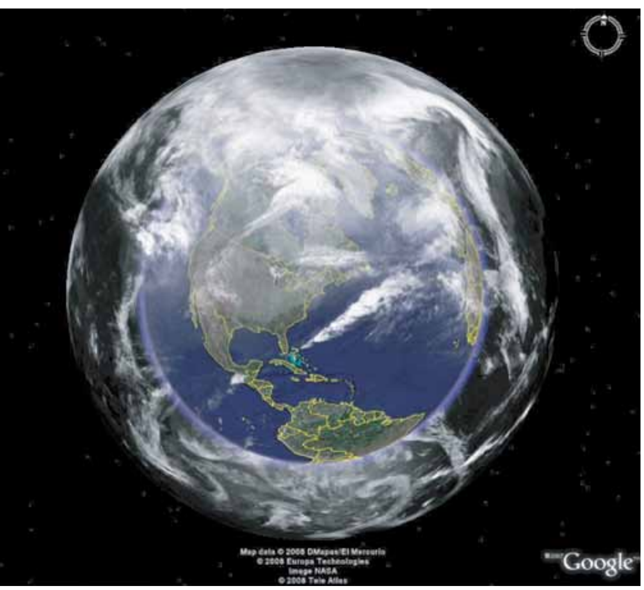
CLIMATE CHANGE

Understanding it Links Directly to Achieving National Space Policy Goals While Being Useful at Tactical and Strategic Levels

BY MAJ MINDY KIMBALL



Earth with cloud cover. Image courtesy of Google.

The 2010 National Security Strategy states that "the danger from climate change is real, urgent and severe." Several recently updated Army and Joint publications list climate change among the most prominent challenges facing our national security. Army Field Manual 3-0 lists climate change in paragraph 1-1 and 1-7 as an important trend that will affect ground force operations. Joint Publication 3-0 tasks regional commanders with the responsibility to "detect, deter, or when directed, defeat threats to the homeland before they arise [in forward regions outside U.S. territories]." The 2010 Joint Operation Environment lists climate change as one of ten trends influencing the world's security, and GEN J.N. Mattis describes in the Foreword that these trends "remind us we must stay alert to what is changing in the world if we intend to create a military as relevant and capable as we possess today."

But why should a Space Professional specifically understand climate change and its implications? Besides the basic doctrine and threat to national security, the June 2010 National Space Policy lists monitoring climate and global change as part of the five goals: "Improve space-based earth and solar observation." Competent space professionals must identify a subject that touches space and do all they can to learn about that subject. They must then inform commanders and provide them with expertise, increased capability and context. Eight distinct reasons for understanding climate change are outlined below, yet this list is surely not complete.

Recognizing the threat

FM 3-0 states that understanding is "essential to the commander's ability to establish the situation's context." A 2007 report by the CNA Corporation (a non-profit think tank that operates the Center for Naval Analysis), National Security and the Threat of Climate Change, stated that "climate change can act

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as a threat multiplier for instability in some of the most volatile regions of the world." The 2007 United Nations report by the Intergovernmental Panel on Climate Change outlines specific regions of the world susceptible to impacts from climate change as well as the nature of the specific impacts – strain on natural resources, limited water supply, flooding, drought, sea level rise, etc. Ignoring a legitimate threat does not reduce it, it simply makes that threat more likely to have negative impacts when it materializes. As more nations realize the effects of climate change, international data needs are likely to increase demand for environmental monitoring capabilities – the most effective and comprehensive means of which are usually space-based sensors.

Intelligence value

A knowledge of the impacts of climate change can guide strategic planning and policy planning by providing predicted conflict areas. Predicting the type of threat, together with the geographic area can increase efficiency in how space resources are designed, funded and allocated. For example, the Intergovernmental Panel on Climate Change report estimates that a coastal city like Calcutta, India will see more than 30 million people displaced by rising sea level over the next 50-100 years, whereas loss of glacial ice in the Caucasus Mountains – together with less snow pack in drier winters – will cause massive drought in Georgia, Armenia, Azerbaijan, and Turkey. Simple population density information indicates that each meter of sea level rise will result in 100 million displaced persons worldwide – so-called "climate refugees" – through loss of land surface. We know where those places are, and we should be investing in contingency planning to face the threat of conflict resulting from climate refugees.

Changing effectiveness of sensors

Changing atmospheric composition means changes in signal attenuation for different frequencies. Particulate matter is probably the most significant impact – dust, ash, soot – , but water vapor, methane, carbon dioxide, and chlorofluorocarbons also change the way signals travel through the atmosphere. If the changes can be predicted, sensors can possibly be adapted to capitalize on new atmospheric conditions – or at least knowledge can be obtained as to which signals will be negatively impacted in the coming decades. Changing greenhouse gas composition and water vapor also will affect thermal blooming and atmospheric distortion of lasers.

Facilities

Most launch sites are in coastal locations where sea level rise may have a direct threat on established facilities – especially on our east coast. This situation makes sea launch a much more attractive option. With one meter of sea level rise, the launch facilities at Cape Canaveral and Wallops Island will quickly be inundated (see GoogleEarth images). Long term planning must account for the design, mapping, and acquisition of alternate launch facilities.

Logistics

The effects of climate change – and the subsequent strain on natural resources – will alter the way we use and acquire launch resources, transportation, maintenance and materiel. As hydrocarbon-based fuels become more scarce, expensive, and extracted from areas of increased conflict, the need for alternative energy will drive innovation that may benefit launch and lift capability. Advances in solar technology will benefit satellite systems. The cost and security of precious metals will change the budgets and costs of new space-based systems.

Sensor capabilities

As weather patterns change, certain areas of the world will have increased or decreased cloud cover. For some areas, this will create opportunity for increased remote sensing – infrared and visible – but other areas such as radar will only be suitable for sensors not impacted by weather. Being able to predict these changes may drive decisions on optimal orbits.

Emerging Battlespace

As ice cover changes and sea levels rise, the maps of the world will change. Shipping lanes are already opening in the Arctic Ocean, and increased maritime traffic will drive additional demand for search and rescue, mapping, and communications capabilities. The changes in terrain will also result in more demand for civil/military traffic monitoring (mostly maritime), strategic launch, and air and missile defense capabilities.

Energy resources

Advances in alternative energy will benefit space technology. The Department of Defense can capitalize on this or lag behind while other nations reap the benefits of an adapted industrial complex and stronger economy. Potential technology such as space-based solar power would dramatically alter military operations and support to civil operations, while facilitating new possibilities for infrastructure development in austere locations – according to the National Security Space Office report on space-based solar power.

Space professionals have a responsibility to seek out advances in technology and integrate new information into their personal and professional development. Climate change is not a political issue, and it is happening in the operating environment. If space professionals are to maintain usefulness at both the tactical and strategic level, they owe it to services and commands to fully understand potential threats to and opportunities for national security.

Author's Note

To read more about climate change and some real impacts to national security, the following documents are a good start: CNA Corporation 2007 report on National Security and the Threat of Climate Change: http://securityandclimate.cna.org/report/ .

Army Energy Strategy for the End of Cheap Oil, Nygren, Massie, and Kern, 2006, US Military Academy at West Point: http://peakoil-hongkong.com/download/usmilitarypeakoildiscussion.pdf.

Defining Some Terms

Climate vs. Weather

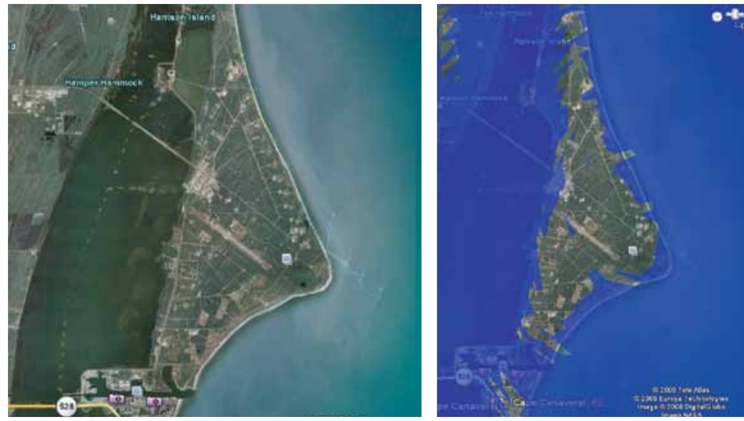
Climate and weather are very different things. They are on different scales of time. Weather is deciding to wear shorts or a jacket today, and climate is whether you own snow boots and long-johns. Climate categories describe averages of weather over several decades, whereas weather can only be predicted three to five days out (at best). It is important to get facts from the right source on climate change – a meteorologist studies weather, a climatologist studies climate, and a paleoclimatologist studies ancient climates. Each of these professions has the capacity to understand climate change, but it is important to discern where the facts or commentary come from.

Global Warming

Global warming is a misnomer and a misunderstood term for what awaits the earth in the coming century. Climate change is the term most scientists use because it more accurately describes the fact that every square inch of the Earth experiences different reactions to changing earth-atmosphere systems. As the climate changes, some places will get cooler, and others will get hotter. Bottom line, there will be more extremes and the average weather over many decades will be different from our recent past.

Theory vs. Hypothesis

In science, a theory is a conclusion based on facts and observations that are scientifically testable. A theory is above facts in the pecking order, it is not a guess or hypothesis. A law is above a theory in science – i.e. you have the "theory of relativity" and the "theory of plate tectonics," then the "laws of gravity" and the "laws of thermodynamics." Furthermore in science, one constantly second-guesses the observations and tries to prove oneself *wrong*. There are no beliefs, just conclusions. "Do you believe in global warming" is a poor question that displays a fundamental misunderstanding of science. A better question is "do you conclude that climate change is happening?" The overwhelming scientific consensus is "yes." But it is very important to gather as much information as possible to constantly test and re-test the theory. This is good science.



Cape Canaveral today (at left) and with one meter sea level rise (water shaded in blue at right) using GoogleEarth animations based on elevation.

Wallops Island today (top) and with one meter sea level rise (water shaded in blue below) using GoogleEarth animations based on elevation.

What is Happening?

Causes

Most of the causes of climate change boil down to the makeup of gases in earth's atmosphere. The atmosphere has been changing for a very long time, and the idea that the relative levels of molecules in our air should stay constant is preposterous. Plants grow, animals die, forests get cut down, volcanoes erupt, ice freezes and melts, humans burn wood and fossil fuels. Each of these processes change the gaseous makeup of the atmosphere.

Greenhouse Effect

Physics provides the explanation that greenhouse gases warm the atmosphere – and surface of the Earth – by trapping heat. Molecules have a natural resonance – they "vibrate" at a certain frequency. As sunlight enters the atmosphere, it comes in as shortwave radiation. About 30 percent of this radiation is reflected and escapes the atmosphere as shortwave radiation – also called albedo. The rest of the incoming solar radiation – insolation – is absorbed into surfaces to heat those surfaces and some of that heat gets re-radiated as longwave radiation. Greenhouse gases resonate at just the right frequency to block the longwave radiation and reflect it back to the earth's surface, thus heating the earth and the lower atmosphere. The more molecules of greenhouse gas in the atmosphere, the more individual waves of longwave radiation reflect back to earth instead of escaping to space.

Goldilocks Planet

Humans enjoy a "Goldilocks" planet, where a little bit of greenhouse effect is just right. Mars does not have enough atmosphere to provide a greenhouse effect, and its average surface temperature is -81 degrees F. Venus has an almost completely carbon dioxide atmosphere, with a "runaway" greenhouse effect, and its average surface temperature is 855 degrees F. Proximity to the Sun is not completely responsible for Venus' hot temperatures – Mercury is closest to the sun, but has no atmosphere, and its surface temperatures average 333 degrees F.

Ancient Climates

For the last 20,000 years, the gaseous makeup of our atmosphere has been relatively constant. Carbon dioxide levels have been in the 200-250 parts per million (ppm) range for the last one million years, that is until this century, where the carbon dioxide levels have risen to 390 ppm (and are continuing to rise at about 2.2 ppm per year). Temperature and carbon dioxide content are coupled systems – a change in one can force a change in the other. There are some natural causes and some feedback mechanisms contributing to the rise in global average temperatures, but human activity is primarily responsible for the rapid increase in greenhouse gases – mainly carbon dioxide, but several others as well – which is in turn forcing global temperatures to rise. Human factors include, but are not limited to, deforestation, agriculture and burning coal/wood/oil.

Ocean Acidification

In addition to changing the atmosphere, rising carbon dioxide levels change the acidity of the oceans. Ocean water takes up carbon in its water chemistry, but it can only take in so much. The more carbon in the ocean, the more acidic the water, and this water actually prevents ocean life (corals, shellfish, etc.) from growing shells and skeletons to survive.

BIO

MAJ Mindy Kimball

is an FA40, currently enrolled as a student at the Command and General Staff School at Fort Belvoir, Va.